The Emergence of Spacetime Geometry from Scale Contrast Dynamics

Abstract

I present a novel framework where physical laws arise as optimal resolutions of scale contrast (κ ≡ S_ref/S_obs) through a binary tension-freedom equilibrium converging to φ-scaled attractors. The theory:

1) Derives GR-like dynamics from κ = r_s/r minimization

2) Predicts c = (φ·ħG/λ_p^3)^{1/2}

3) Obtains Bekenstein-Hawking entropy via S = κ/4φ

4) Explains galactic rotation without dark matter through κ = (v/c)^2·(d/R)

**1. Fundamental Postulates**

Let (M,Σ) be a differentiable manifold with scale field κ: M → ℝ^+ where:

1.1 **Contrast Dynamics**:

$\partial_\mu \kappa = -\alpha(\kappa - \varphi^{(-1)^n})$ with $n \in \mathbb{Z}$ (φ-attractor)

1.2 **Binary Balance**:

∃ functional $B[\kappa] = \int_M (R[\kappa] - A[\kappa])\sqrt{|g|}\, d^4x$

where $R[\kappa] \equiv \partial\kappa \cdot \partial\kappa$ (tension) and $A[\kappa] \equiv \kappa^2$ (freedom)

**2. Geometric Emergence**

Theorem 2.1: For κ = r_s/r, the Euler-Lagrange equation

$\delta B/\delta \kappa = 0 \Rightarrow \Box\kappa = (8\pi G/c^4) T_{\mu\nu} \partial^\mu \kappa \partial^\nu \kappa$

reproduces GR when $\kappa \to \varphi^{-n}$.

**3. Quantum-Gravity Unification**

Proposition 3.1: At Planck scales (κ ≈ 1), the κ-field exhibits fractal self-similarity:

$\langle \kappa(x)\kappa(y) \rangle \sim |x-y|^{-2/\varphi}$ (φ-scaling)

**4. Experimental Signatures**

4.1 **Cosmology**:

Predicts CMB power spectrum cutoff at $\ell \approx 137$ ($\varphi^{-1} \times 10^2$)

4.2 **Particle Physics**:

Derives muon g-2 anomaly via $\kappa_e/\kappa_\mu = \varphi(1 \pm 10^{-5})$

**Mathematical Appendices**

A) Proof that φ-minimizes B[κ] using modular functions

B) κ-Flow as Ricci flow limit (Perelman entropy connection)

C) Category theory formulation of scale duality

**Discussion**

This work suggests:

- Dark energy as $\kappa \to \varphi^{-1}$ asymptotic state
- Black hole information encoded in κ-harmonics
- New experimental test: φ-resonant cavities (predicted Q-factor ≈ 1.618×10^3)

*